APPENDIX C

CHARACTERIZATION DATA NEEDS

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APPENDIX C

CHARACTERIZATION DATA NEEDS

C1.0 DATA QUALITY OBJECTIVES STRATEGY AND STATUS

C1.1 INTRODUCTION

The Waste Feed Delivery (WFD) program has again undergone significant redirection in the last year. The Readiness-to-Proceed (RTP) effort was completed in January 1998 and in July 1998, the U.S. Department of Energy (DOE) signed a design phase contract with BNFL Inc. The BNFL Inc. contract differed significantly from the guidance DOE provided for the RTP effort. A new branch of the DOE, the Office of River Protection (ORP) was established to manage the tank waste cleanup. As a result of the ORP redirection throughout the year, the order of the waste feed envelopes (tank sequence) was revised, the amounts of feed to be delivered was redefined, and the schedule for delivery was delayed. This resulted in a re-assessment of WFD's ability to deliver waste feed and a revision to the WFD Project's mid-level logic and schedule. The mid-level logic has been revised for Phase 1 retrieval and feed staging of tanks to meet Envelopes A, B, C, and D. A rebaselining of the logic to include the above and other impacts of the ORP redirection was frozen as of February 8, 2000, and is the basis for Readiness-To-Proceed 2 (RTP-2).

The mid-level logic diagrams provide a framework to systematically define issues facing WFD. Some issues can be addressed without the need for more data (i.e., an engineering solution is robust enough to address the uncertainties), while other issues may require obtaining data on tank contents. Where new data are needed, WFD is using the data quality objective (DQO) process to define the precise problem and solution and the needed data.

In determining the WFD characterization needs, a careful analysis was performed on all aspects of the WFD Program that might require characterization of tank contents. This process is referred to as the DQO process and the result of the DQO process is the following:

- A determination of the feed envelope for a candidate source tank
- A determination of the transfer characteristics of the waste in a candidate source tank
  A determination of the quantity of feed expected to be delivered to BNFL Inc. from the candidate source tank.

Completion of this DQO effort permitted a precise listing of the analyses needed. In addition, this effort allowed a determination of what information was not needed because the program had all the data required.

C1.2 DATA QUALITY OBJECTIVE PROCESS

The DQO process (EPA 1994) was created as a systematic approach to identify problems/issues facing a program or project and to define the specific data needed to address those identified problems/issues.[1] When a DQO application involves many individual problems, it is best to think about creating a DQO for each problem, tailoring the DQO to the precise problem at hand). With the development of the mid-level logic diagrams, WFD has organized the waste feed staging and disposal program into discrete, sequential steps that permit methodical and precise examination and identification of specific problems/issues facing each step.

The starting point in the tailored DQO efforts on the waste feed staging and delivery program is to assemble small groups of key technical staff who understand the details of specific steps[2] or groups of steps in the mid-level logic diagrams. Using the descriptive text and associated issues discussion developed for each step requiring a DQO, this small group carries out the first four "steps" of the DQO process (e.g., defining the [1] PROBLEMS/issues associated with each step, the [2] DECISION or answer required to resolve the problem/issue, the [3] INPUTS required to address or resolve the problem/issue, the [4] BOUNDARIES of the problem/issue). Upon completion of focused discussions on the four "steps," each of these small groups will have assembled a precise list of problems/issues and decisions/answers associated with each step in each mid-level logic that requires a DQO. Knowing the problem and the associated decision is crucial to developing a useable DQO.

During the input "step" of the DQO process, the small group of key technical staff determine what data are required to address the issue. Or, the group might determine (if obvious or based on further detailed study) that it would be more cost-effective to resolve the issue with an engineering solution (e.g., put in a higher horsepower mixer pump rather than measuring precisely the viscosity of the liquid) and therefore, not need to collect more data.

If the small group determines that data are important in resolving a problem or issue, they next gather existing information to determine whether that existing data are sufficient to address the problem. If existing data are not sufficient, then the remaining "steps" of the DQO process are pursued because new data are required. These remaining "steps" determine the (5) DECISION RULE, the (6) ERROR TOLERANCE, and how to (7) OPTIMIZE the sampling and analysis activities, so the required new data can be precisely defined and cost-effectively obtained. Completing these "steps" completes the DQO process for the problem identified in a given step or group of steps of the mid-level logic diagrams that requires a DQO.

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[1]The DQO process consists of seven steps: (1) State the Problem, 22) Identify the Decision, (3) Inputs to Decision, (4) Define the Boundaries, (5) Develop Decision Rule, (6) Limits on Decision Error, and (7) Optimize Design for Obtaining Data.

[2]The word step is used in two contexts -- the steps in the mid-level logic and the steps of the DQO process. To distinguish the context, steps (without quotes) apply to the steps of the mid-level logic. "Steps" (in quotes) applies to the various steps of the DQO process.

C1.3 CURRENT STATUS OF DATA QUALITY OBJECTIVES EFFORTS

WFD has developed several DQOs. Two DQOs "Confirm that Tank T Meets Batch X" for low-activity waste (LAW) and high-level waste (HLW) respectively. One DQO addresses "Tank Waste Transfer Control" and a previously existing DQO deals with "Retrieval Equipment Design." A DQO to address the "Certification of Waste Feed for Transfer to BNFL Inc." is scheduled for next year. Additionally, a DQO was developed to define the sampling and analyses required for the 241-AZ-101 Mixer Pump Tests.

The following are the DQOs for Phase 1 LAW feed and for HLW feed.

- Confirm Tank T Meets Batch X (LAW) -- completed
- Confirm Tank T Meets Batch X (HLW) -- completed
- Tank Waste Transfer Control -- completed
- Retrieval Equipment Design -- completed
- 241-AZ-101 Mixer Pump Test -- completed
- Certification of Waste Feed for Transfer to BNFL Inc. -- Fiscal Year (FY) 2001
- Other DQOs will be identified and developed as the need arises.

C1.4 TEST PLAN EFFORTS

The “Confirm Tank T” DQOs direct the development of test plans for obtaining specific information for waste feed staging and delivery to support completion of Phase 1 activities. These tests include the following.

- Dilution and dissolution testing of candidate Phase 1 LAW feed sources
- Rheology testing of candidate Phase 1 HLW feed sources
- Shear strength and viscosity
- Particle size distribution
- Density and settling rate measurments
- Sludge composition as a function of settling.

C1.5 ADDITIONAL DISPOSAL PROGRAM CHARACTERIZATION NEEDS

A best-basis inventory (BBI) of chemical and radionuclide components in the 177 underground waste tanks has been prepared by Process Engineering. Maintenance of the inventory, reconciliation of the data, and update of the data will be provided on an annual basis to support WFD data needs.

The BBI includes 25 chemical and 46 radionuclide components that represent 99 wt% of the tank contents and over 99 percent of the radionuclide activity, respectively. The summation of individual tank components represents the global (total) inventories for the tanks and is recommended to support all end users of the inventory data (Kupfer et al. 1999).

The inventories are published in the respective Tank Characterization Report (TCR) for each tank. In instances where a TCR has not been issued, the tank inventory is issued as a preliminary TCR. The official repository for the best basis tank inventories is the Tank Characterization Database (TCD) (LMHC 1998).

The best-basis tank-by-tank inventories will be used as the approved inventory for future revisions of the Tank Farm Contractor (TFC) Operation and Utilization Plan (O&UP). Presently, the inventory does not contain all of the analytes listed in the Privatization Contract feed envelope specifications. A BBI DQO may be required to obtain additional analytical data where justified.

Expansion of the data set to include confidence intervals and other program-specific needs (liquid/solid splits, wash/leach splits, etc.) is underway. Both uncertainty estimates and wash/leach factor data are now available in the TCD.

C1.6 SUMMARY

The DQO process provides a systematic approach to problem definition and problem solving, especially when new data are needed to solve the problem. In an area where there are multiple problems, the DQO process works best when its users carefully focus the problems into their many individual problems and each is properly sequenced. WFD has done this when they created the mid-level logic diagrams.

The mid-level logic provides an excellent starting point for developing the DQOs needed so the characterization program knows specifically what WFD requires. These DQOs also help to assure that WFD can meet the first feed delivery to the private vendor and are important to defining activities for the FY 2001 multi-year work plan and the FY 2001/2002 sampling plans.

Based on carefully defined problems/issues associated with each step in the mid-level logic diagrams, decisions can be made on whether existing data are sufficient or new data are required or an engineered solution can effectively address the problem/issue. If new data are required, a DQO can be developed quickly. As problems/issues arise that require new data from a specific tank, all steps in the mid-level logic diagrams will be queried to determine what other

problem/issues need resolution that can benefit with results from this tank. The associated DQOs can then be listed and combined into one sampling and analysis plan.

A process is in place to develop all the required DQOs for those steps in the mid-level logic diagrams for Phase 1 waste feed staging and delivery when the time is ripe for preparing the DQO. Taking time to pursue the various issues presented in the mid-level logic is equivalent to carrying out the first four steps of the DQO process.

The final product from the DQOs and the documentation of the test plan requirements is an integrated list of what tanks need to be sampled, what samples are needed, and what analyses are needed to support the WFD program. The list was developed using available information and will be statused and updated as data become available or new characterization needs are defined.

Table C-1 sets the Initial Order and Extended Order LAW and HLW waste tank sample needs for WFD. As shown in Table C-1, sampling is complete for all but one LAW and one HLW tank of the Initial Order tanks. Currently sampling of all Initial Order tanks is expected to be complete by the end of the 2001 calendar year. Table C-1 also provides a status of the testing. Testing and analysis of the Initial Order samples are expected to be complete by the end of 2002.

Table C-1. Waste Feed Delivery Waste Tank Sample Needs.

Tank	Sample amount/matrix	Program status	Certification analysis	Feed batch staged for delivery
LAW Initial Order				
AP-101	Have Sample	Sampling Complete; Dilution Testing 2001	Have Sample, Certification Analysis 2001	Yes
AZ-101 (LAW)	Have Sample	Sampling Complete, Test Plan Complete. Tests in Progress	Available for Certification	Yes
AZ-102 (LAW)	Have Sample	Sampling Complete, Test Plan Complete. Tests in Progress.	Needs Mixer Pumps	Yes
AN-102 (LAW)	Have Sample	Dilution Tests Scheduled FY 2000	Available for Certification	Yes
AN-104 (LAW)	Have Sample	Tests Complete HNF-3352 Sept, 1998	TBD	Half of Tank Requires Staging to AN-101
AN-107 (LAW)	Have Sample	Dilution Tests Complete RPP-5456 Dec. 9, 1999	Available for Certification	Yes

Table C-1. Waste Feed Delivery Waste Tank Sample Needs.

Tank	Sample amount/matrix	Program status	Certification analysis	Feed batch staged for delivery
AN-105 (LAW)	Have Sample	Tests Complete HNF-SD-DTR-046, Rev. 0A Nov. 1999.	TBD	Half of Tank Requires Staging to AN-102
SY-101 (LAW)	Need Sample	Require sample from AP-104 and AN-101 after staging.	Certification Analysis will be performed on samples taken from the Staging tanks.	Staging in progress into AP-104 and AN-101
AN-103 (LAW)	Have Sample	Test Plan complete, Tests in Progress	TBD	Half of Tank Requires Staging to AN-102
AW-101 (LAW)	Have Sample	Testing Complete, HNF-4964, Rev. 0, Sept. 1999	TBD	Half of Tank Requires Staging to AN-102
LAW Extended Order				
AW-104 (LAW)	2000- gm Composite	Check to determine if samples are required	TBD	Requires Staging to AP-104
SY-103 (LAW)	2000- gm Composite	Sampling Scheduled 2/21/2000	TBD	Requires Staging to AN-101
AP-106 (LAW) (SWL)	2000 - gm composite	Check to determine if samples are required	TBD	Half of Tank Requires Staging to AN-102
S-102 (LAW) (S-103, S-105)	2000- gm Composite	Check to determine if samples are required	TBD	Requires Staging to AP-101
S-105 (LAW) S-102, S-108)	2000- gm Composite	Check to determine if samples are required	TBD	Half of Tank Requires Staging to AN-102
AP-105 (LAW) (SWL)	2000- gm Composite	Check to determine if samples are required	TBD	Half of Tank Requires Staging to AP-104
AP-108	2000-gm Composite	Check to determine if samples are required	TBD	Yes
HLW Initial Order				
AZ-101 (HLW)	Have Sample Poor solids Recovery, May require re - sampling	Sampling Complete, Test Plan Complete. Testing in Progress	Available for Certification	Yes

Table C-1. Waste Feed Delivery Waste Tank Sample Needs.

Tank	Sample amount/matrix	Program status	Certification analysis	Feed batch staged for delivery
AZ-102 (HLW)	Have Sample	Sampling Complete, Test Plan Complete. Tests in Progress.	Needs Mixer Pump	Yes
C-106/AY-102 (HLW)	Have Sample	Test Plan complete, Rheology Testing 2001	Have Sample, Certification Analysis 2001	Yes
AY-101 (HLW) Blend with C-104	Have Sample.	Test Plan Draft complete, Rheology Testing 2001	Certification Analysis will be performed on samples taken from the Staging tanks	Requires C-104 Staging to AY-101
C-104 (HLW)	Have Sample	Report Complete: RPP-5798, Rev 0, Feb. 8, 2000	N/A	Requires C-104 Staging to AY-101
SY-102 (HLW) Blend with AW-103 (40%)	Need Core Samples (800g)/r from two risers.	Push Sampling scheduled 11/2000	Certification Analysis will be performed on samples taken from the Staging tanks	Requires Staging to AZ-101
HLW Extended Order				
AW-103 (HLW)	Have Sample	Tests Scheduled for 2001	N/A	Requires Staging along with C-107 to AY-102
C-107 (HLW) Blend with AW-103	Need Core Samples (800 g)/r from two risers.		TBD	Requires Staging to AY-102
AW-104 (LAW/HLW) Blend with AW-103 (35%)	Need Core Samples (800 g)/r from two risers.		TBD	Requires AW-103 Staging to AW-104

FY = Fiscal year
HLW = High-level waste
LAW = Low-activity waste
RPP = River Protection Project
TBD = To be determined.

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C2.0 PHASE 1 CANDIDATE LOW-ACTIVITY WASTE FEED TANKS

This appendix contains a summary of the major issues associated with Characterization data needed to support LAW feed staging.

1. Data from the first feed tanks for delivery of waste feed to BNFL Inc. (241-AP-101, 241-AZ-101, 241-AZ-102, 241-AN-102, 241-AN-104, 241-AN-107, 241-AN-105, 241-SY-101, 241-AN-103, and 241-AW-101) were evaluated to determine if the current data are sufficient for establishing that the tank contents conform to the associated envelope requirements. The reviews suggest that except for sulfate in 241-AN-104, the existing information on chemical and radiochemical composition in these tanks are good enough to assure that the desired envelopes can be met. This determination was made after a careful review of the BBI database that was prepared for the feed staging analysis for these tanks. Except for the components mentioned above, all other components are "far enough away" from the envelope limits so conformance to envelope requirements is not a concern. "Far enough away" is defined as being different than the envelope limit by more than the value of the uncertainty in the measurement.

2. For each LAW feed source tank, specific tests need to be carried out to: (a) establish the ease of putting contents into solution, (b) establish the ease of mixing the contents of the tank to make the contents homogeneous, and (c) assure that no precipitates or gels are formed on settling or transfer (Garfield 1997). Tests on 241-AN-104, 241-AN-105, 241-AN-107 and 241-AW-101 contents are complete, tests on 241-AZ-101, 241-AZ-102 and 241-AN-103 are underway and tests on 241-AP-101, 241-AN-102 and 241-SY-103 are scheduled for 2001. Tests on subsequent LAW feed source tank waste samples are planned for FY 2002 and beyond.

3. Characterization for Equipment Design

   To establish the equipment needed for waste feed staging, Alternatives Generation and Analyses (AGA) reports and Trade Studies are performed. These studies may require specific characterization data from specific tanks (e.g., waste needs to be processed to a required specification to be compatible with the equipment for transferring and immobilization). Or, the data needed may be so gross (e.g., is the waste liquid or sludge) that BBI can provide the required data. Here the equipment is designed to be robust enough to handle a wide range of feed compositions.

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C3.0 PHASE 1 CANDIDATE HIGH-LEVEL WASTE FEED TANKS

This appendix contains a summary of the major issues associated with Characterization data needed to support HLW feed staging.

1. An analysis similar to that performed on the Initial Order LAW tanks was performed on the Initial Order HLW source tanks (241-AZ-101, 241-AZ-102, 241-AY-102/241-C-106, 241-AY-101/241-C-104, 241-C-104 and 241-SY-102/241-AW-103) to determine if the current data are sufficient for establishing that the tank contents conform to the Specification 8 requirements. The reviews suggest that the existing information on chemical and radiochemical composition in these tanks are good enough to indicate that the solids may meet HLW Envelope D specifications but the liquids probably do not meet the LAW Envelope A, B, or C specifications. This determination was made after a careful review of the BBI database and ESP calculations that were used to predict the final composition of the sludge relative to the unwashed Envelope D.

2. For each HLW feed source tank, specific tests need to be carried out to: (a) determine aqueous and caustic insoluble fractions of sludge, (b) determine rheology tests to establish the ease of mixing and pumping the contents of the tank, (c) assure that no precipitates or gels are formed on settling or transfer, (d) determine the amount and characteristics of the undissolved solids, and to (e) determine the amount of glass that will result from immobilization of each tanks waste. Tests on 241-C-104 contents are complete, tests on 241-AZ-101 and 241-AZ-102 are underway and tests on 241-AY-101/241-C-104 and 241-AY-102/241-C-106 are scheduled for 2001. Tests on subsequent HLW feed source tank waste samples are planned for FY 2002 and beyond.

3. Characterization for Equipment Design

   The same analysis described for Phase 1 LAW feed staging equipment design will be needed for the HLW feed staging.

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C4.0 DEVELOPMENT NEEDS

While the specific LAW and HLW data needs are described in the previous sections (C2.0 and C3.0), there are some general characterization needs that support successful completion of Phase 1 and preparation for Phase 2. One is completion and maintenance of the BBI. This inventory will become the official inventory upon which many decisions will be based. The inventory needs to be as accurate and complete as possible. Another is continuation of the efforts to define, sample and test representative tanks to provide information about waste types that can be extrapolated to unsampled tanks. The available data from sampling events and laboratory process tests need to be reviewed and the basis for sampling and analysis updated to best meet WFD needs. These are discussed below in more detail.

1. The Hanford Tank Waste Operation Simulator (HTWOS) model is being used to evaluate single shell source tank sequencing to assure the appropriate feed for Phase 2, given the limited volume available in the double-shell tanks and other parameters affecting the retrieval sequencing of the single-shell tanks. The BBI is being relied on to define the contents of the single shell tanks for the retrieval sequence and blending analysis. Data are needed to be able to extrapolate from sampled tanks to unsampled tanks to decrease the uncertainty associated with these analyses.

2. The efforts to sample and test representative tanks using the Sort On Radioactive Waste Type (SORWT) grouping (47/12; Kupfer 1995) was done, among several reasons, to simplify/reduce the need to characterize the contents of each tank. Retrieval sequencing is relying in part on the product of this strategy to determine composition in those tanks where there is little data. The initial conclusions on grouping need to be validated.

   Thirty-nine of 47 SSTs have been sampled and 34 have undergone enhanced sludge wash (ESW) testing. Nine of the 39 sampled tanks have not been tested because of insufficient sample recovery, insufficient sludge available after characterization analyses, or because the sample was of a saltcake waste and ESW testing was not justified. The remaining 17 tanks (of the 47) need to be reviewed to determine which should be sampled to provide the information required about the wastes in the tanks. The sampling schedule should also be reviewed to determine which tanks to be sampled would make suitable substitutes for the tanks that were sampled but not tested.

   The analysis producing the logic of 47/12 in 1995 was based on tank information available through 1994. Since 1994, there has been a large number of tanks sampled. The available information needs to be reviewed to validate the use of SORWT groupings and determine what information can be used to guide sample selection to resolve issues or answer questions.

3. Process Testing

3a. Enhanced Sludge Washing

The ESW tests were started to confirm a prior decision (*Tank Waste Technical Options Report* [Boomer et al. 1993]) that the ESW option (caustic leaching pretreatment) had the lowest overall life-cycle cost and was the preferred alternative for pretreating the HLW sludge before vitrification. As a result of these tests, a DOE Independent Review Team concluded that as much as 80 percent of the tank waste sludge could be processed using ESW, with the balance of the sludge material being treated with additional processes to meet DOE's goals on reducing HLW glass production. This review closed Tri-Party Agreement (Ecology et al. 1996) Interim Milestone M-50-03.

Demonstrating ESW performance with currently unrepresented waste types, confirming ESW performance with waste types heavily weighted in chromium, and expanding the oxidative leaching performance data base for selected wastes are the short-term priority needs.

Parametric ESW tests are tentatively planned on samples from SORWT groups IV (241-SX-108), VI (241-B-101), VIII (241-BX-110 or 241-BX-112), IX (241-U-102, XI (241-A-103) and XXV-F (241-C-102). After completion of these tests, 92 percent of the sludges will be represented in the ESW database.

Oxidative leaching studies are directed at waste types with the highest potential to affect mass-weighted removal factors (i.e., those with the largest amount of leach-resistant chromium). One area of focus will be salt cakes where the high chromium content is expected. Specific samples have not been identified at this point. The nature of leach-resistant chromium is unknown, so determination of the residual species through microscopy studies will be an aspect of the oxidative leaching studies.

These data will be required for the Phase 2 Request for Proposal.

Priority for Phase 1 work has deferred preparation of any specific Phase 2 needs, therefore the strategy outlined above is being followed until specific direction is developed. One change from this strategy is the expectation that BNFL Inc.'s facility will continue processing HLW after Phase 1 contracted quantities are complete and that the RPP will ask CHG to give priority to SST sludges that meet the Envelope D feed specification.

3b. Settle Decant Testing

These tests were started to obtain data on representative Phase 2 SST sludges. All planned Phase 2 settle/decant tests have been completed pending Phase 2 data needs definition. Any settle/decant data needed for Phase 1 will be obtained in rheology tests.

4. Evaluation of all existing data

It is anticipated that as the amount of data is increased in inventory development, ESW tests, and settle/decant testing, additional work may be required to evaluate existing data in anticipation of changing data needs. For example, further examination of other individual component inventories (e.g., sulfate) may increase the ability to control IHLW volumes for individual HLW batches during Phase 2.

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